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CHARACTERISTICS OF LIQUID AND SOLID WASTES GENERATED AT FOUR MAJOR HOSPITALS OF SRINAGAR CITY, KASHMIR

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ABSTRACT

Physical composition analysis of the solid waste generated from the four major hospitals of Srinagar city (SKIMS, Lal Ded,SMHS and G.B Pant hospitals) revealed the predominant proportion comprising of combustible waste (98.2%) than the non combustible waste (1.3%) Incineration could be probably the appropriate and recommendable disposal method for the hospital waste generated in Srinagar city. Analytical observations revealed that the liquid biomedical waste of only SKIMS conformed to the prescribed norms.

Key Words: Physical composition, solid waste, liquid waste, combustible waste, incineration, biomedical waste

Hospitals are service oriented institutions that provide observational, diagnostic, research, therapeutic and rehabilitative services vital for our life and health. But the waste generated from medical activities represents a real problem of living nature and human world. Waste is an unavoidable byproduct of human activities, which has been prevading our environment for centuries and will continue to contaminate our surroundings in the foreseeable future (Campbell, 1988; Stamenkovic and Kralj, 2007).

Several surveys have provided an indication of typical biomedical waste generation. Data from some of these surveys shows that generation of biomedical waste differ not only from country to country but also within a country (Boatright *et al*., 1995). Waste quantity and quality depends on numerous factors such as established waste management methods, type of hospital, hospital specialization, type and number of patients treated on daily basis etc. (WHO, 2006). Reports from developed countries indicate 1-5 Kg of waste generated per bed per day (Planning Commission, 1995). Data though insufficient from developing countries, indicate comparatively lower quantum of generation i.e. 1-2 Kg/day/bed. On an average J&K hospitals generate 1.5-2 Kg waste per bed on daily basis (Yashpal and Mahajan, 2006). Different types of biomedical waste have their own specific characteristics and might need different disposal methods. Little data on the composition of this waste from different medical facilities is available. A better understanding of the composition of biomedical waste is fundamental in order to choose the best disposition alternative.

Liquid waste is generated on account of disinfection of tubings, catheters, intravenous sets, washing, cleaning and housekeeping (Purvi *et al.,* 2006) and should be treated before its disposal.

STUDY AREA

Four major hospitals in the Srinagar city were selected for the present study. All the four hospitals have different characteristics in terms of their size, treatment technology and the type of patients received. Therefore, it is possible /expected that their waste composition would differ. The sites include:

SITE 1: Sheri-Kashmir Institute of Medical Sciences (SKIMS), a tertiary care hospital having bed strength of 600. It caters nearly all the socio economic class of people.

SITE 2: Shri Maharaja Hari Singh Hospital (SMHS) in Karan Nagar area of Srinagar city was selected as site 2. It is the teaching hospital associated to Government Medical College, Srinagar and is the biggest hospital in terms of bed capacity (750 bedded).

SITE 3. Lalla Ded Hospital an associated hospital of GMC in Wazir Bagh of Srinagar city is a 500 bedded teaching hospital. It caters patient with gynecological and obstetrical ailments. It is the biggest maternity hospital in the Kashmir valley.

SITE 4: G.B Panth hospital a joint venture between J&K Govt. and the Badamibagh cantonment board is a 200 bedded hospital, located in a Badami Bagh area of Srinagar city. It caters to Children Patients mainly.

MATERIAL AND METHODS

For the determination of physical composition, samples were randomly selected from central waste collection areas. In simple random sampling method every item has the same probability of being selected. The total mass of waste samples was approximately 90 kg. The waste samples were divided into six parts. Two of the six parts were chosen for further analysis, thus total mass loading for composition characterization was 30 Kg, which was randomly mixed again for physical analysis .

For the physicochemical analysis of hospital effluent, standard methods as described by Saxena (1998) and Gupta (2000) were followed. The results were recorded and compared with the prescribed limits for liquid waste given in Biomedical Waste (Management and Handling), Rules 1998 (Purvi *et al.,* 2006). Waste water sampling was performed by grab sampling method, by which waste water was collected at one time. For determination of suspended solids, sample was taken from a location where the effluent was free flowing and well mixed.

pH

pH was determined on site using pre-calibrated digital handy pH meter (Model 201).Water sample from the surface was collected in a glass bottle and electrodes were dipped in it. Meter was switched on and readings were recorded.

Temperature

Temperature was measured by mercuric thermometer of range 0- 50^{0}C. Surface water was collected in a container and its temperature was recorded immediately by dipping the thermometer for about one minute.

Suspended Solids

100ml sample of hospital effluent was filtered through oven dried and pre weighed whatman No. 4 filter paper in a beaker. Then the filter paper was again dried, weighed and its final weight was recorded. The calculations for suspended solids were made as per the following formula:

Suspended Solids (mg/l)

= Final Wt. of filter paper Initial Wt. x1000

Vol. of sample taken (ml)

Oil and Grease

For determination of oil and grease in the hospital sample, 4ml of H_2SO_4, 20ml of petroleum ether and a little amount of ethyl alcohol was added in a 100 ml sample. After shaking it well, the whole suspension was transferred to a separatory funnel and allowed to stand for sometime so that the two layers, upper one of petroleum ether and lower one of water became

distinct. Lower layer of water was then discarded and upper layer of petroleum ether was then passed through a filter paper soaked in petroleum ether in a pre-weighed glass beaker of weight, W_1. Some more petroleum ether was passed through the filter paper so that no oil and grease remain stuck to the paper. Then the beaker with contents was kept on a water bath, so as to evaporate the petroleum ether. And the weight of beaker with residue was recorded W_2. The calculations for oil and grease were made as per the following formula:

$$\text{Oil and grease (mg/L)} = \frac{(W_2 - W_1)}{\text{Vol. of Sample (L)}} \times 1000$$

Where W_1 and W_2 are taken in gram

Standards for Liquid Waste

The effluent generated from the hospital should conform to the following Limits*:*

Table 1. Standards for hospital effluent (Source: BMWM Rules, 1998)

S. No.	Parameters	Permissible limits
01.	pH	**6.5 – 9.0**
02.	Suspended Solids	100mg/L
03.	Oil and grease	10 mg/L
04.	Temperature	40 °C

RESULTS AND DISCUSSION

The physical analysis of solid biomedical waste generated from the four selected hospitals revealed that plastics formed the major component of the waste stream(34.2%) and occurred in the form of drip sets, blood bags, glucose bottles, catheters, disposable syringes etc. Cotton constituted 28.3% of the waste stream. Food waste (23.3%) included mainly uneaten food, fruit peels and food preparation wastes. Paper is one of the important recyclable constituent and during the present investigation paper constituted 10.1% of the waste stream. Cardboard which is mainly used as packaging carton was found in lesser amounts (2.3%). Glass and metallic waste constituted 0.4% and 0.9% of waste steam respectively (Fig.1). Both belong to the non combustible waste category. Glass occurred in the form of vials, medicines bottles etc and metallic waste included scalpels, surgical blades, needles etc.

As such incineration could be the appropriate and recommendable disposal method for biomedical waste, in Srinagar city. On one hand, there are more serious emission concerns associated with the incineration than most alternatives. While on the other hand because incineration is a more established technology, emission concerns have al

been more clearly identified and can manage all types of biomedical waste. However individual incineration for each hospital does not seem to be economically feasible. Further investigation on the physical and chemical characteristics of medical waste was needed for selection and designing of the best disposition methods. Chih- shan and Fu-Tein (1993) after evaluating physicochemical composition of the biomedical waste found that waste consisted of 99.02% of combustible and 0.97% non-combustible components by mass. The combustible wastes constituted paper (16.17%), textiles (9.77), cardboard, wood, and leaves (1.12%), food waste (21.51%), and plastics (50.45%).The non-combustible waste included 0.40% metal and 0.57% glass. Same results were obtained by Elevli *et al. (*2002) in four major hospitals of Sivas Turkey.

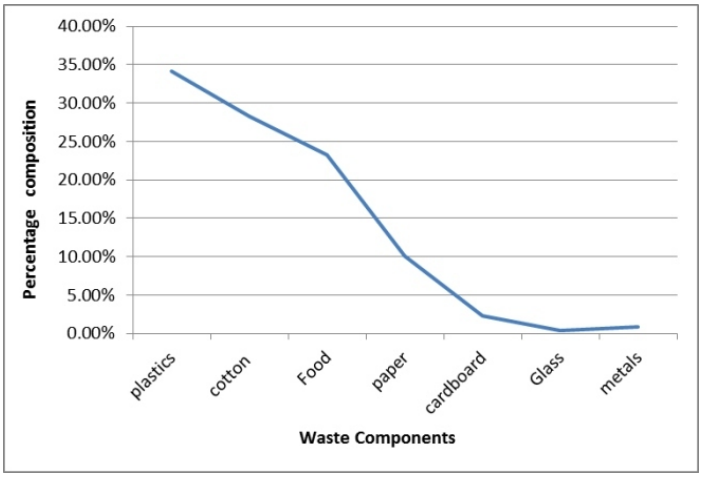

Fig.1. Physical composition of solid waste

Characterization of Liquid Hospital Waste

pH

The pH values were observed to remain towards the alkaline side at all the four hospitals, (Table 2). The values of pH ranged between a minimum of 7.2 to a maximum of 8.4 at SKIMS; minimum of 9.0 to a maximum 10.4 at SMHS Hospital; minimum of 9.0 to a maximum of 9.4 at Lalla Ded hospital, and minimum of 9.7 to maximum of 10.5 at G.B Panth hospital. The mean values in case of four sites were obtained to be 7.9 at site 1; 9.7 at site 2; 9.2 at site 3, and 10.2 at site 4.

Temperature

The temperature ranged between a minimum of 21.4 °C to a maximum of 26.9°C at SKIMS; minimum of 18°C to a maximum of 19.5°C at SMHS hospital; minimum of 18.2°C to a maximum of 21.2°C at Lalla Ded hospital, and minimum of 14°C to a maximum of 16°C at G.B Panth Hospital (Table 3). The mean values in case of four sites were obtained to be 24.6 °C at site 1; 18.7°C at site 2; 19.6°C at site 3 and 14.8 °C at site 4.

Suspended Solids

The amount of suspended solids varied form 80mg/L to 85.3 mg/L at SKIMS; 104 mg/L to 109 mg/L at SMHS hospital; 101mg/L to 107 mg/L at Lalla Ded hospital, and 110.9 mg/L to 115.3mg/L at G.B Panth hospital (Table 4). The mean values in case of four sites were obtained to be 82.5 mg/L at site 1; 107 mg/L at site 2; 104mg /L at site 3, and 113.6 mg/L at site 4.

Oil and Grease

The oil and the grease was not detected in the liquid biomedical waste from the selected hospitals, however further studies need to be carried out.

Table 2. pH values of hospital effluent observed at four major hospitals

S.No.	Hospitals	pH Values						Mean
1.	SKIMS		7.2	7.9	7.8	8.2	8.4	7.9
2.	SMHS	9.0	9.4	9.2	9.7	10.4	10.2	9.7
3.	LALLA DED	9.3	9.0	9.4	9.3	9.2	9.1	9.2
4.	G.B PANTH	9.8	9.7	9.9	10.2	10.5	10.4	10.2

Table 3. Temperature of hospital effluent observed at four major hospitals

S.No.	Hospitals	Temperature (°C)						Mean
1.	SKIMS	21.4	23.2	26.9	25.6	26.0	24.7	24.6
2.	SMHS	18.0	18.2	18.0	19.5	19.3	19.4	18.7
3.	LALLA DED	20.3	21.2	19.8	19.6	18.2	18.3	19.6
4.	G.B Panth	14.2	14.6	14.0	15.3	15.1	16.0	14.8

Table 4. Amount of suspended solids in the hospital effluent

S.No.	Hospitals	SUspended Solids						Mean
1.	SKIMS	80	82.3	81.4	82	84.1	85.3	82.5
2.	SMHS	104	106	108	109	105	108	107
3.	LALLA DED	107	102	105	103	101	106	104
4.	G.B Panth	110.9	114.6	112.8	114.9	115.3	112.4	113.6

From the analytical observations, it was clear that hospital effluent of only SKIMS met the prescribed norms given in Biomedical Waste (Management and Handling) Rules, 1998 because of the treatment given to the liquid waste before its final disposal.

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REFERENCES

Boatright, D.T., Edwards, A.J, and Shaver, K.A.1995. A comprehensive biomedical waste survey. *Journal of Environmental Health.* **57**: 4-8.

Campbell, D. 1988. Hospital waste management in Canada. *Proceeding of the National Workshops on Hospital Waste Incineration and Hospital Sterilization,* U.S. EPA, San Francisco, C.A.

Chih-Shan and Fu-Tien.1993. Physical and chemical composition of hospitalwaste. *Journal of Infection Control and Hospital Epidemiology*,

14(3):145-50.

Elevli, B., Altin, S., Altin, A., and Cerit, O. 2002. Determination of hospital waste composition and disposal methods. A case study. *Journal of Environmental Studies*, **12**(2): 251-55.

Gupta, P.K. 2000. *Methods in Environmental Analysis: Water, Soil, and Air*. Agrobios, Jodhpur (India).

Planning commission, Government of India, Hospital Waste Management 1995: Report of high power committee on urban solid waste management. pp: 35-47.

Purvi, M., Sheth, K.N. and Desai, H. 2006. Characterization and management of biomedical waste in SAE Hospital, Anand : A case study. *Electronic Journal of Environmental, Agricultural, and Food Chemistry,* **5** (6):1579-4377

Saxena, M.M. 1998. *Environmental Analysis, Water, Air and Soil*. Agrobotanica, Vyas Nagar, Bikaner, India

Stamenkovic, M. and Kralj D. 2007. *Health care and waste treatment*, WSEAS int. Conference on Energy Planning, Energy Saving, Environmental Education, Arcachon, France. pp: 116-19.

World Health Organization, 2006. Management of waste from hospitals and health care establishment. Euro Report and Studies Annexure-III Geneva: 1985; WHO, 97.

Yashpal and Mahajan, P. 2006.*Hospital waste management*. An Insight and Approach. pp: 1-86.